The Coulomb Dissociation of ^{8}B

Moshe Gai
Laboratory for Nuclear Science
At Avery Point
University of Connecticut
and
Yale University
[www.phys.uconn.edu]

Coulomb Dissociation of ^{8}B:

1. The $^{7}Be(p,\gamma)^{8}B$ Reaction
2. ^{8}B Solar Neutrinos
3. Recent Unsubstantiated Attack (Seattle)
4. GSI-Weizmann Result
5. E2 Result
6. Extrapolation $S_{17}(0)$???

XX Workshop on Nuclear Dynamics, March 20, 2004

Photo montage, Marie Boscia/Kate Mer

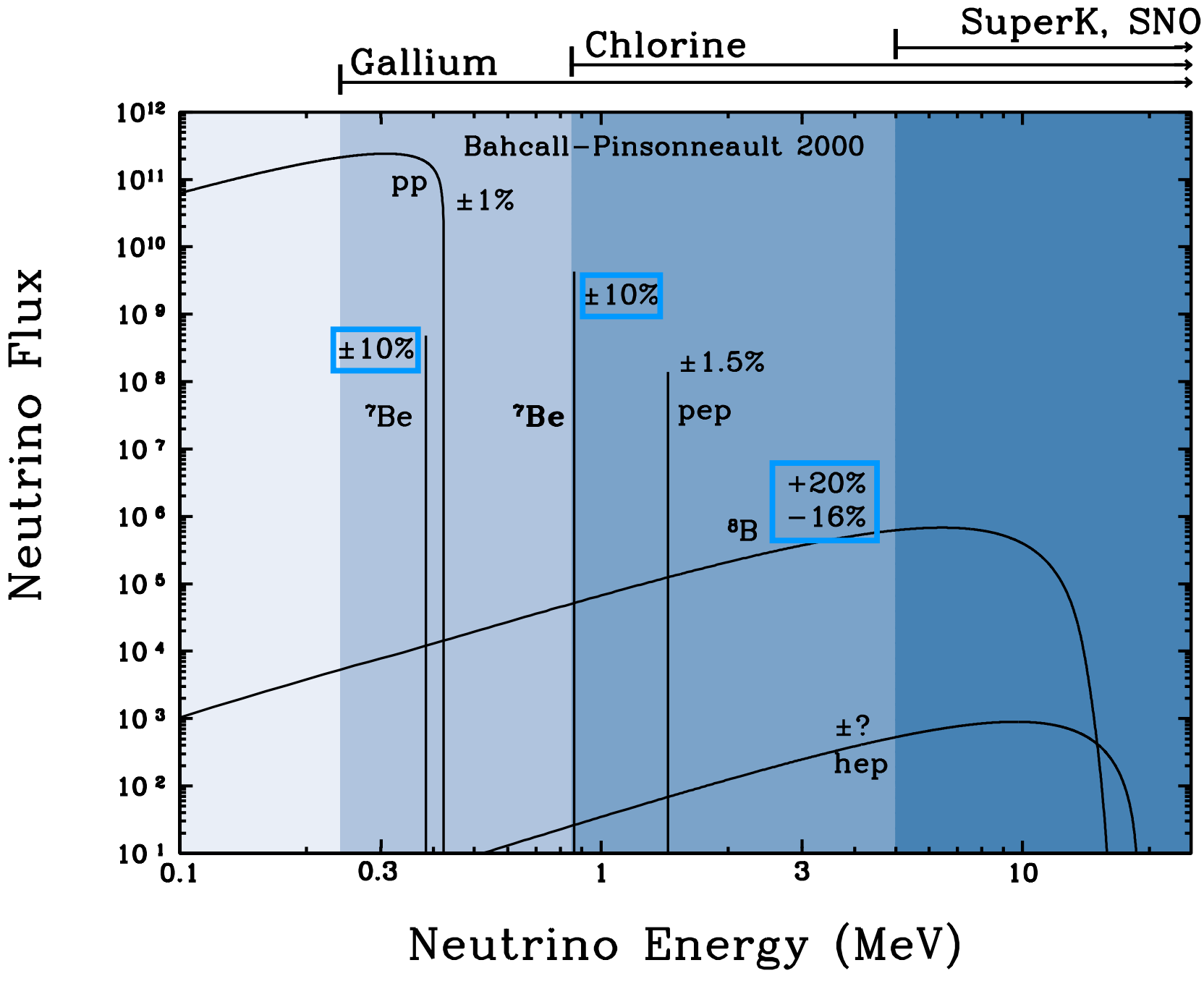


Figure 3. Solar neutrino spectrum with currently estimated uncertainties.

$$\sigma_{17} = S_{17}/E \times e^{-2\pi\eta}$$

$(\eta = Z_1 Z_2 \alpha/\beta)$ $\quad E_{cm} = 18$ keV

Fillipone(1983)

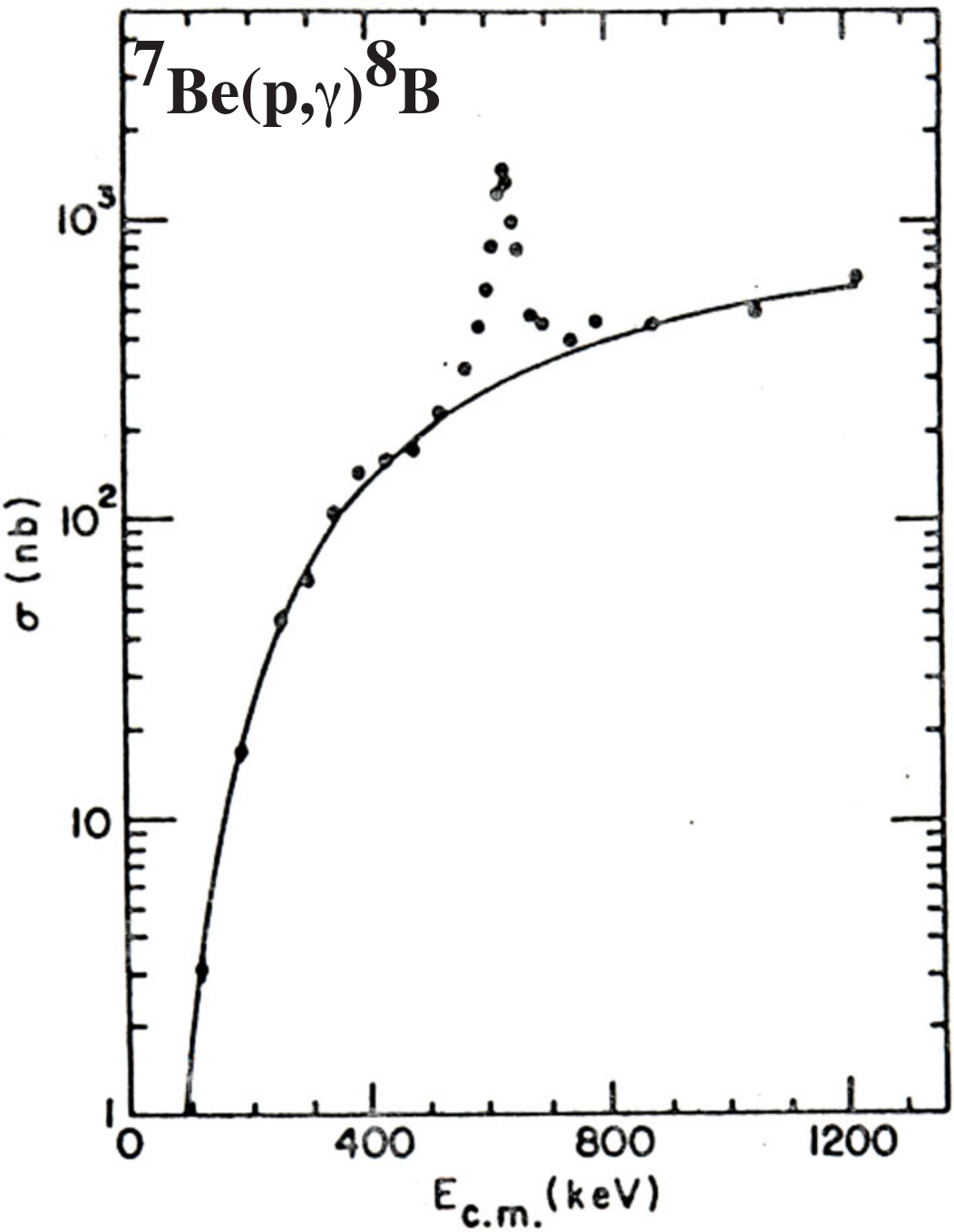


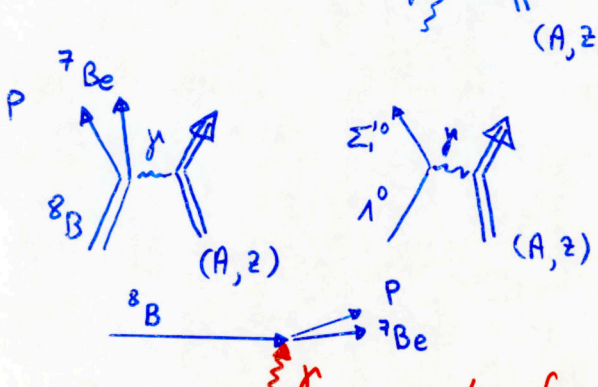
TABLE II: Principal sources of uncertainties in calculating solar neutrino fluxes. Columns 2-5 present the fractional uncertainties in the neutrino fluxes from laboratory measurements of, respectively, the ^{3}He-^{3}He, ^{3}He-^{4}He, p-^{7}Be, and p-^{14}N nuclear fusion reactions. The last four columns, 6-9, give, respectively, the fractional uncertainties due to the calculated radiative opacity, the calculated rate of element diffusion, the measured solar luminosity, and the measured heavy element to hydrogen ratio.

Source	3-3	3-4	1-7	1-14	Opac	Diff	$L\odot$	Z/X
pp	0.002	0.005	0.000	0.002	0.003	0.003	0.003	0.010
pep	0.003	0.007	0.000	0.002	0.005	0.004	0.003	0.020
hep	0.024	0.007	0.000	0.001	0.011	0.007	0.000	0.026
^{7}Be	0.023	0.080	0.000	0.000	0.028	0.018	0.014	0.080
^{8}B	0.021	0.075	0.038	0.001	0.052	0.040	0.028	0.200
^{13}N	0.001	0.004	0.000	0.118	0.033	0.051	0.021	0.332
^{15}O	0.001	0.004	0.000	0.143	0.041	0.055	0.024	0.375
^{17}F	0.001	0.004	0.000	0.001	0.043	0.057	0.026	0.391

± 0.06 BP(00)

CAPTURE REACTION: $^7Be + p \rightleftarrows {}^8B + \gamma$

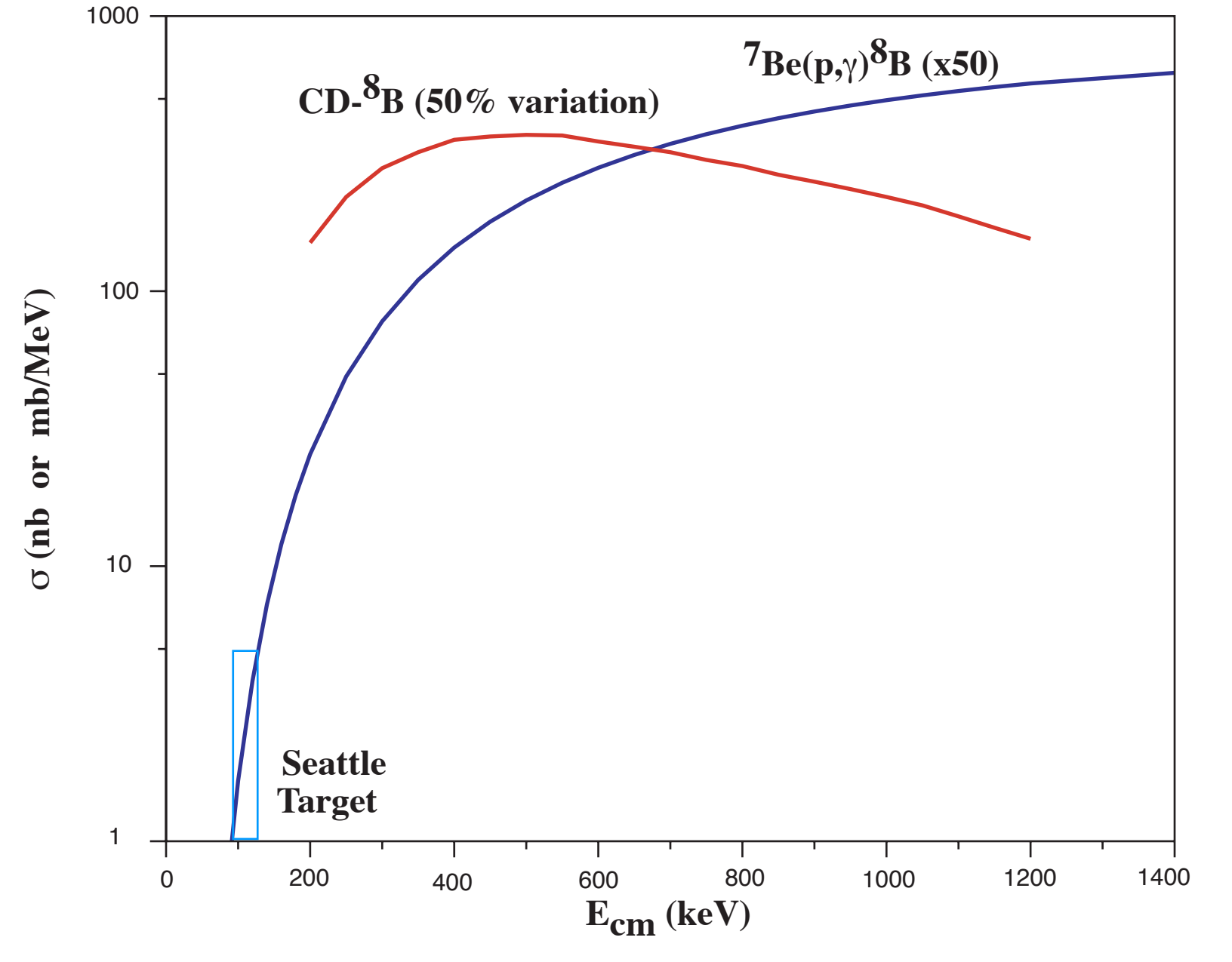
PRIMAKOFF (1951):



ENHANCEMENT: (I) $\pi/k^2 \approx 1,000$

(II) $n_\gamma(E1) \approx 1000$

BAUR, BERTULANI, REBEL - 1986

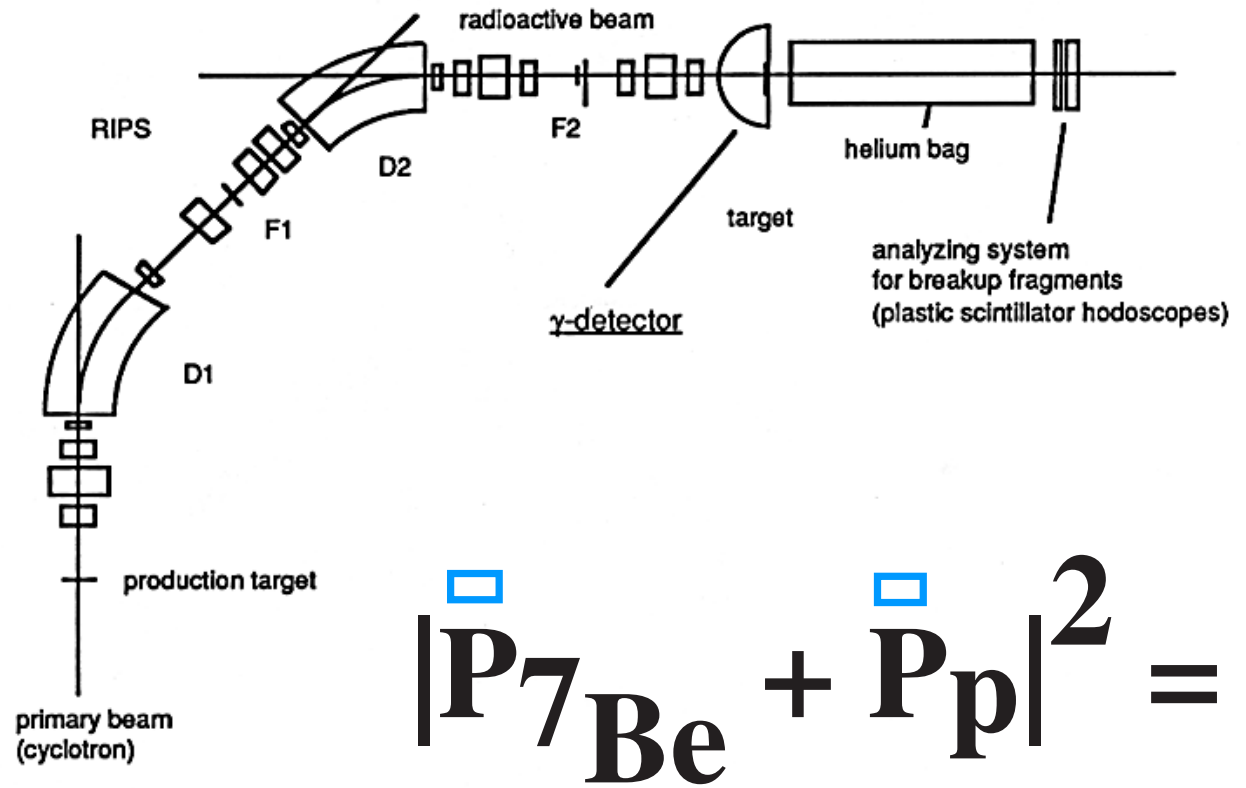

1000
100
10
1
σ (nb or mb/MeV)
0
200
400
600
800
1000
1200
1400
E_cm (keV)
7Be(p,γ)8B (x50)
CD-8B (50% variation)
Seattle
Target

^{8}B Breakup 実験覚え書き

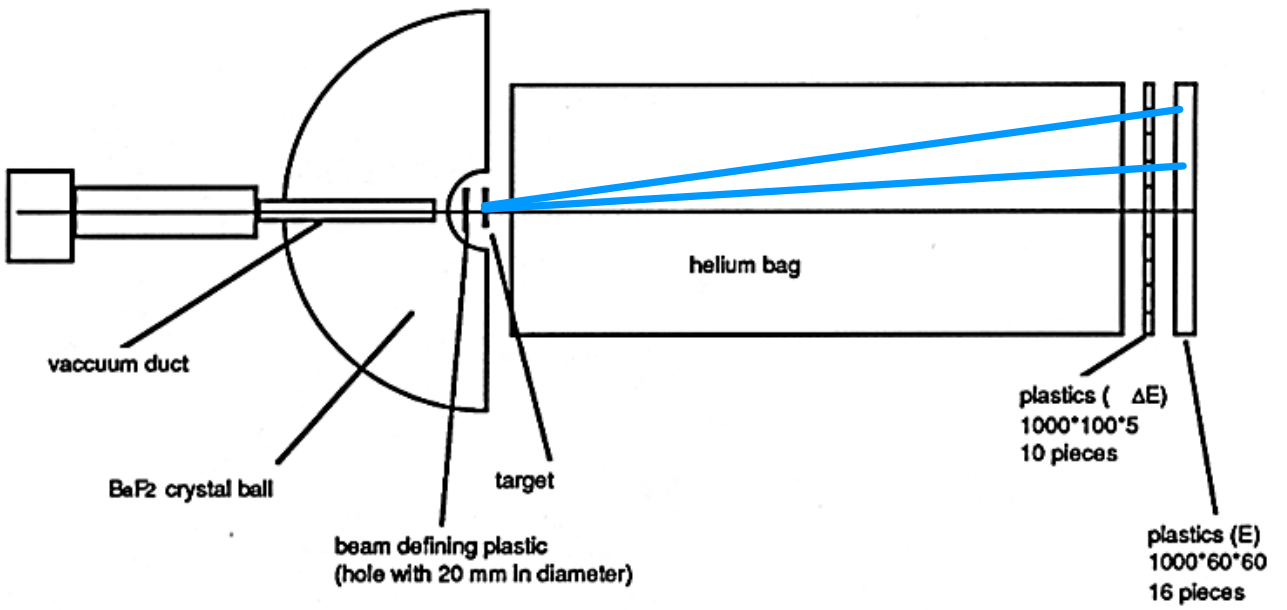
RIKEN - RIPS

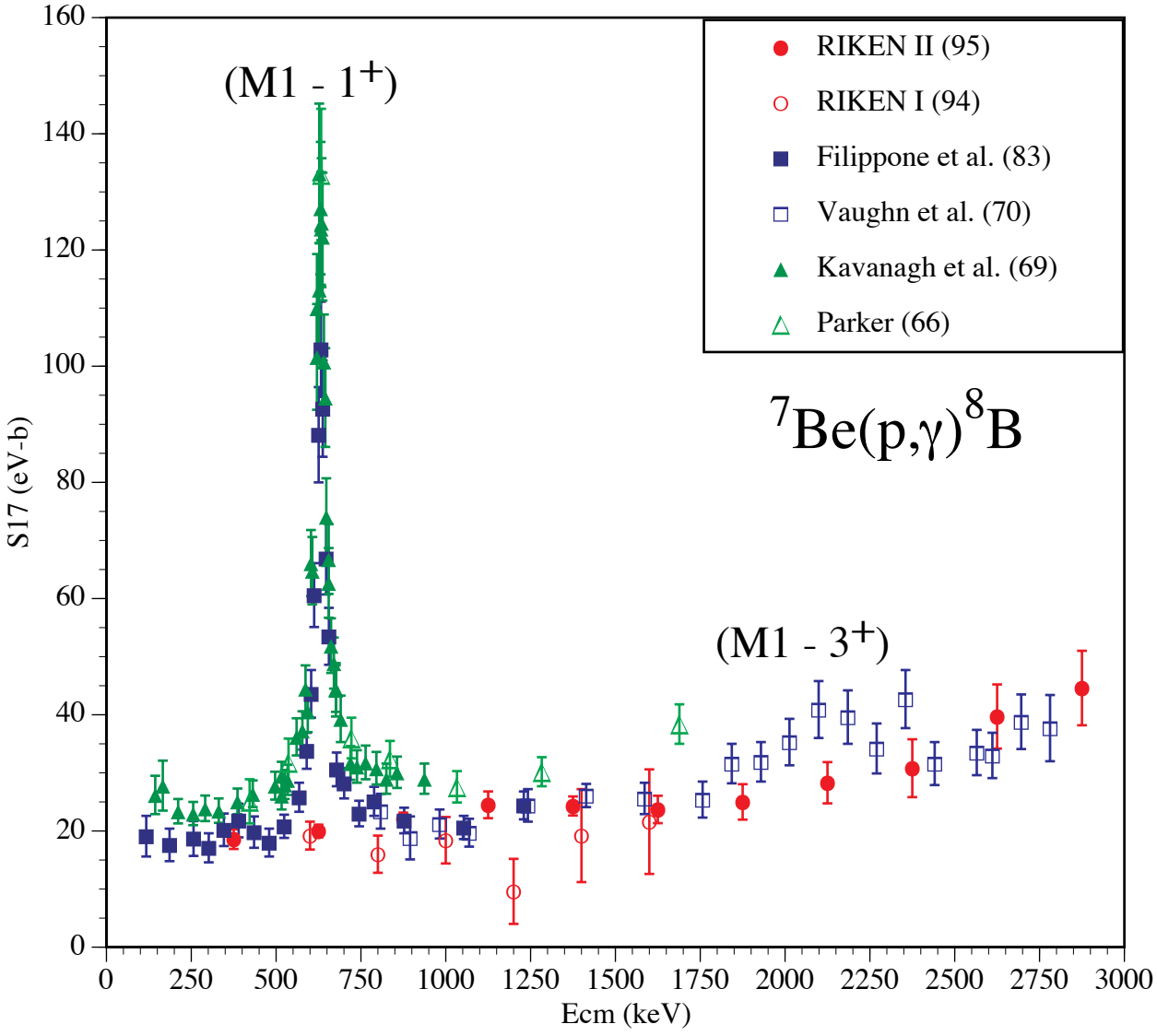
20 Mar. 1992 本林

setup



$$|\vec{P}_{^7Be} + \vec{P}_p|^2 = M^2$$

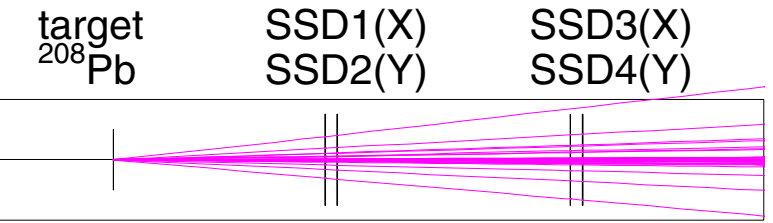


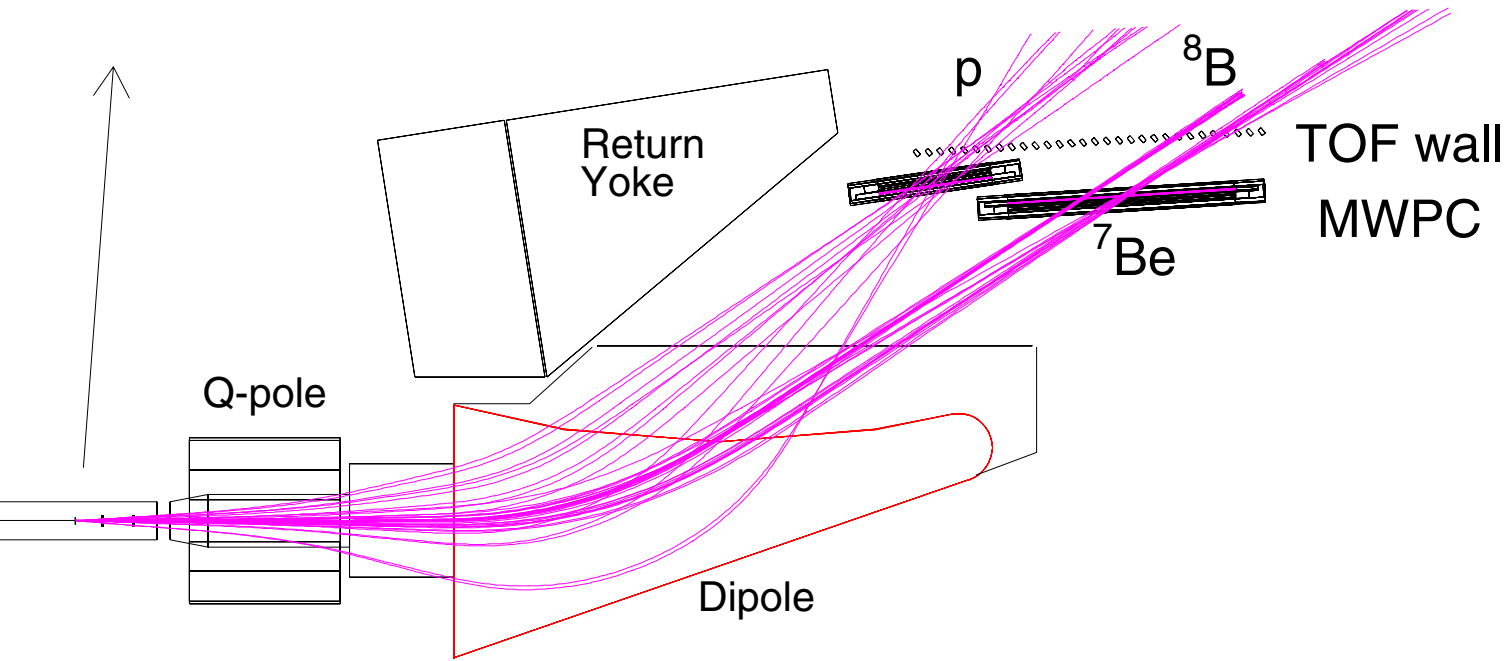

RIKEN II (95)
RIKEN I (94)
Filippone et al. (83)
Vaughn et al. (70)
Kavanagh et al. (69)
Parker (66)
(M1 - 1+)
(M1 - 3+)
7Be(p,γ)8B
S17 (eV-b)
Ecm (keV)
0
20
40
60
80
100
120
140
160
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000

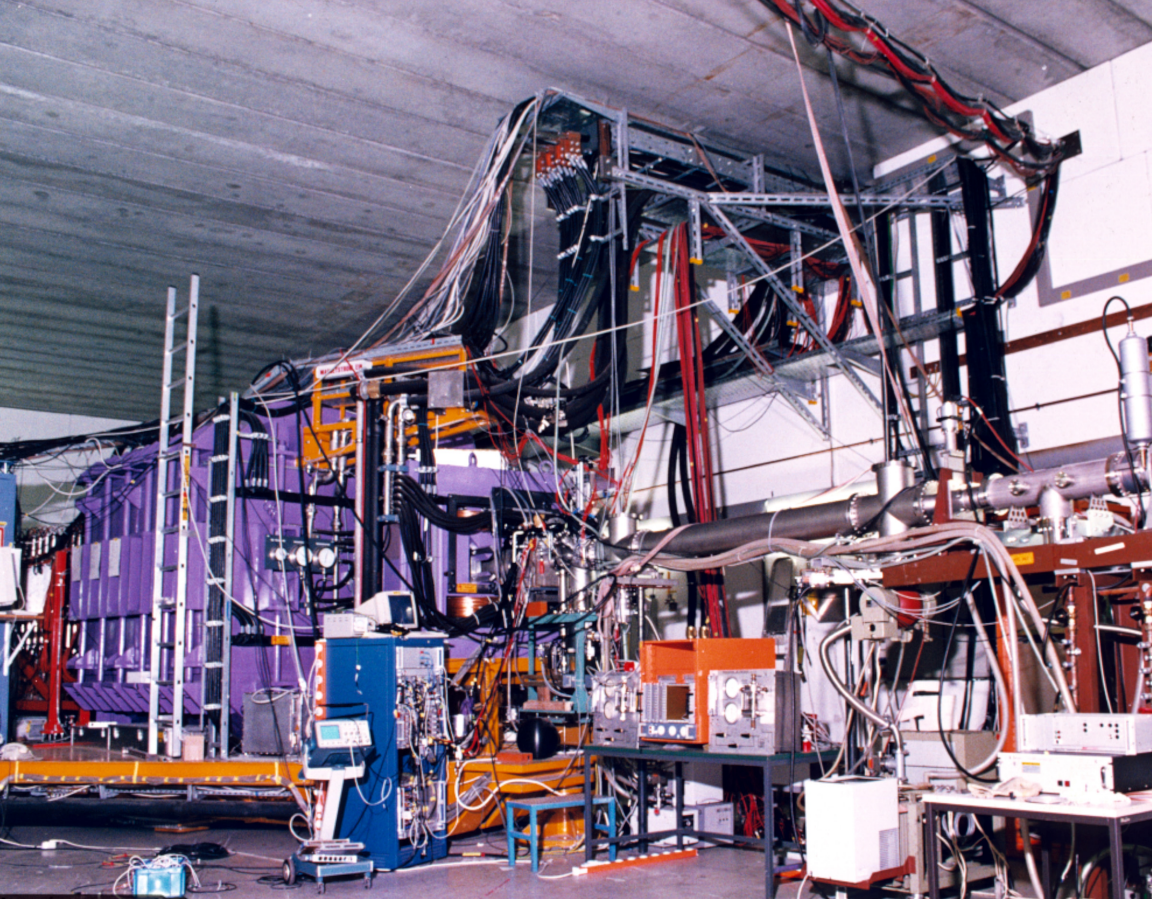
When a Dog Speaks it Does Not Matter What it Says.

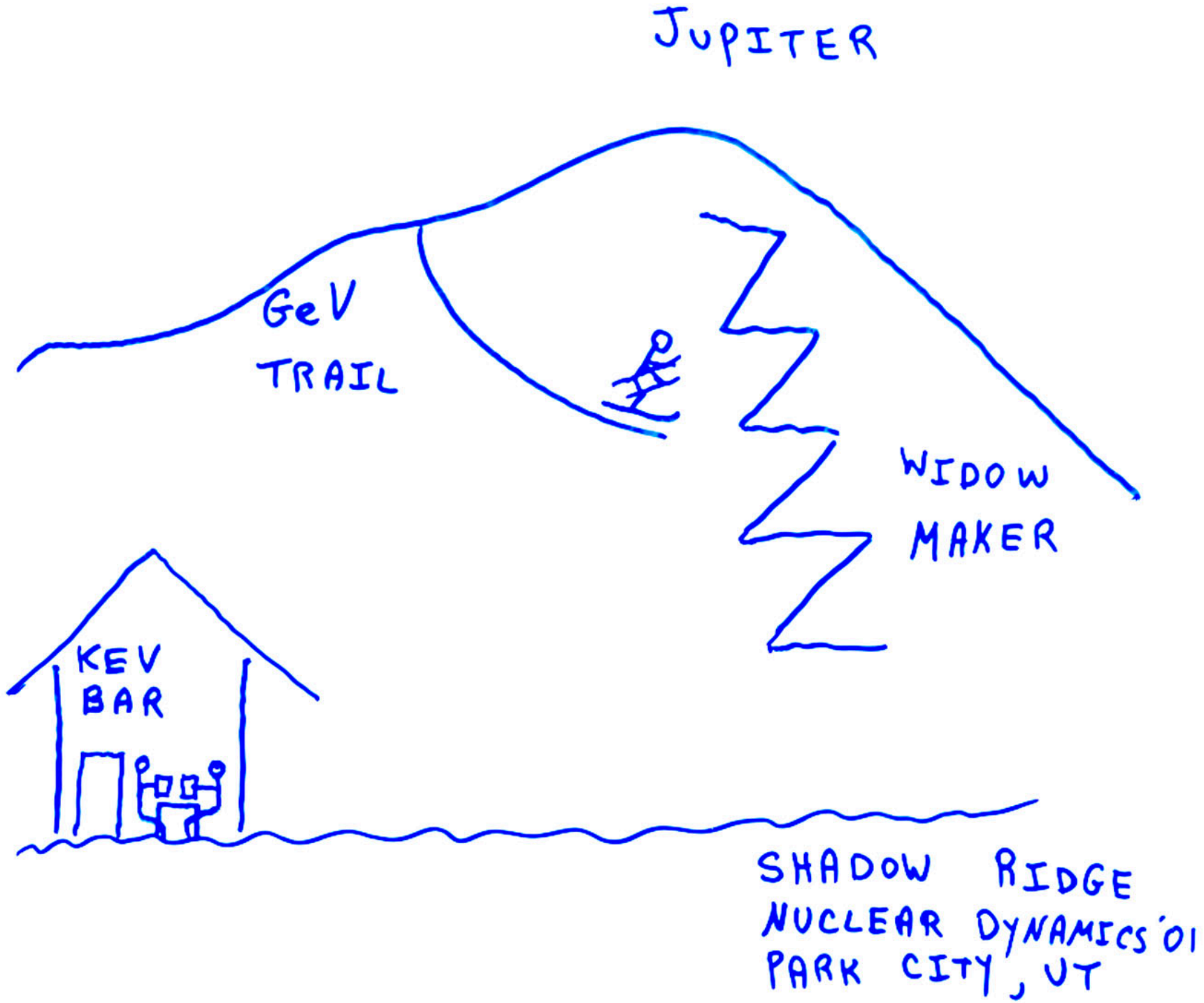
Igal Talmi

KAOS @ GSI


target
^{208}Pb
SSD1(X)
SSD2(Y)
SSD3(X)
SSD4(Y)


p
^{8}B
TOF wall
MWPC
Return
Yoke
^{7}Be
Q-pole
Dipole




JUPITER
GeV
TRAIL
WIDOW
MAKER
KEV
BAR
SHADOW RIDGE
NUCLEAR DYNAMICS '01
PARK CITY, UT

COMMENTS

Comments are short papers which criticize or correct papers of other authors previously published in the **Physical Review.** *Each Comment should state clearly to which paper it refers and must be accompanied by a brief abstract. The same publication schedule as for regular articles is followed, and page proofs are sent to authors.*

Comment on "$E2$ contribution to the $^8B \rightarrow p + ^7Be$ Coulomb dissociation cross section"

Moshe Gai
Deptartment of Physics-U46, The University of Connecticut, Storrs, Connecticut 06269
and Department of Physics, Yale University, New Haven, Connecticut 06511

Carlos A. Bertulani
Instituto de Fisica, UFRJ-Cidade Universitaria, Caixa Postal 68528, 21945-970 Rio de Janeiro, Brazil
and Gesselschaft für Schwerionenforschung Darmstadt m.b.H., KPII, Planckstrasse 1, D-64291 Darmstadt, Germany
(Received 25 May 1994)

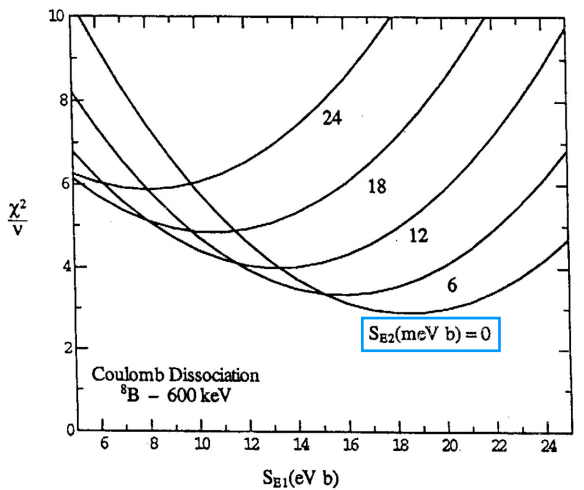
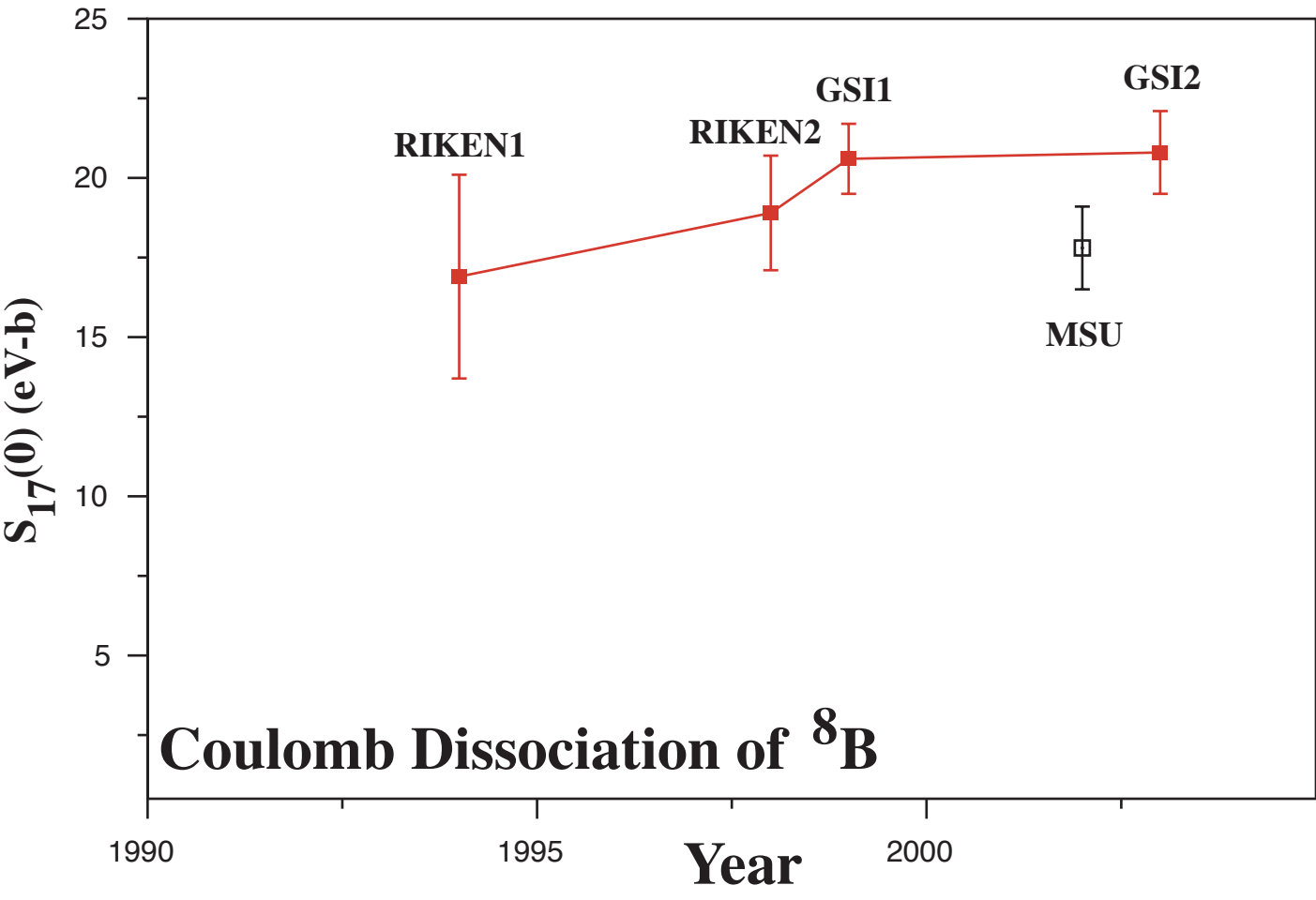
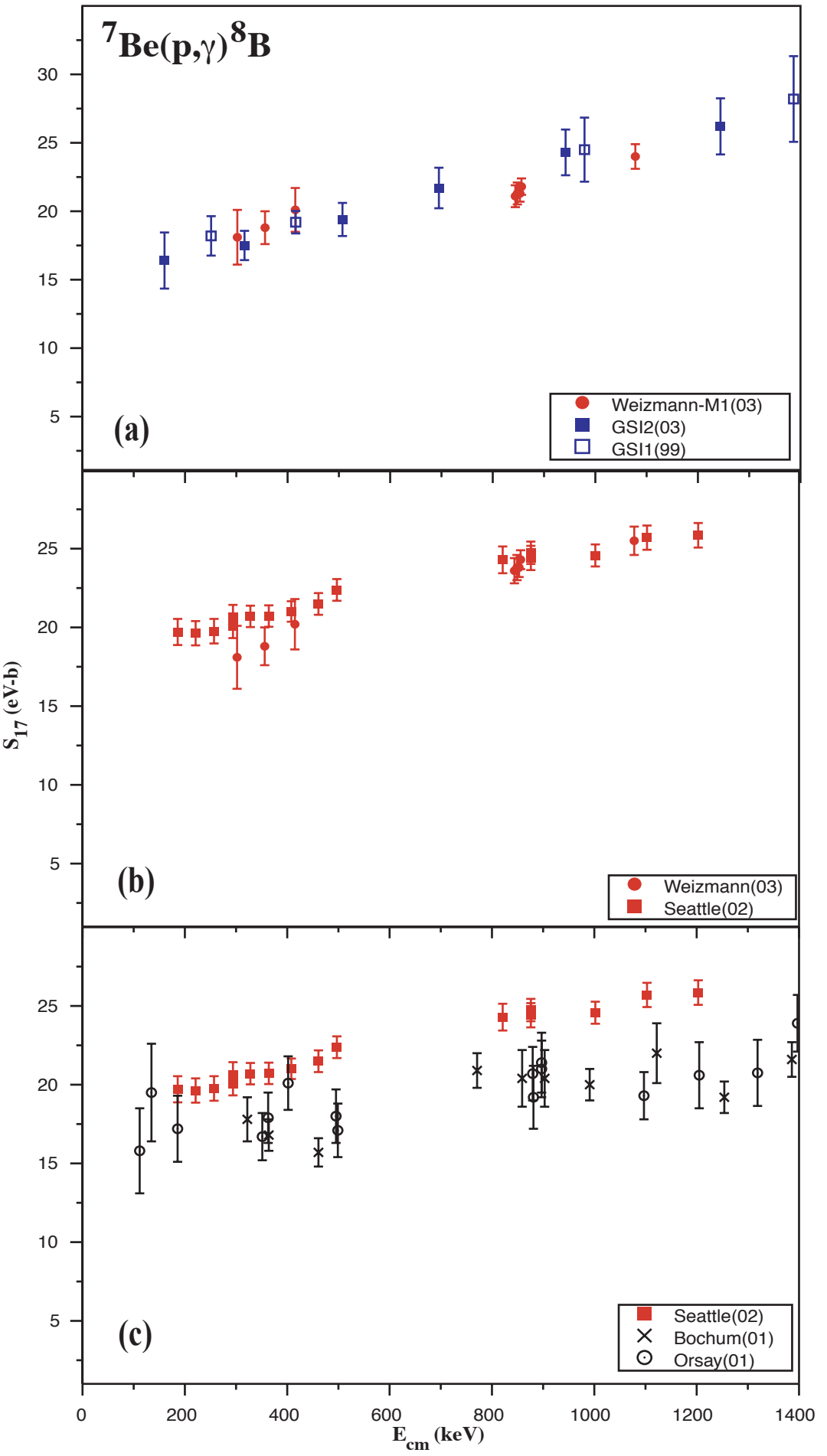
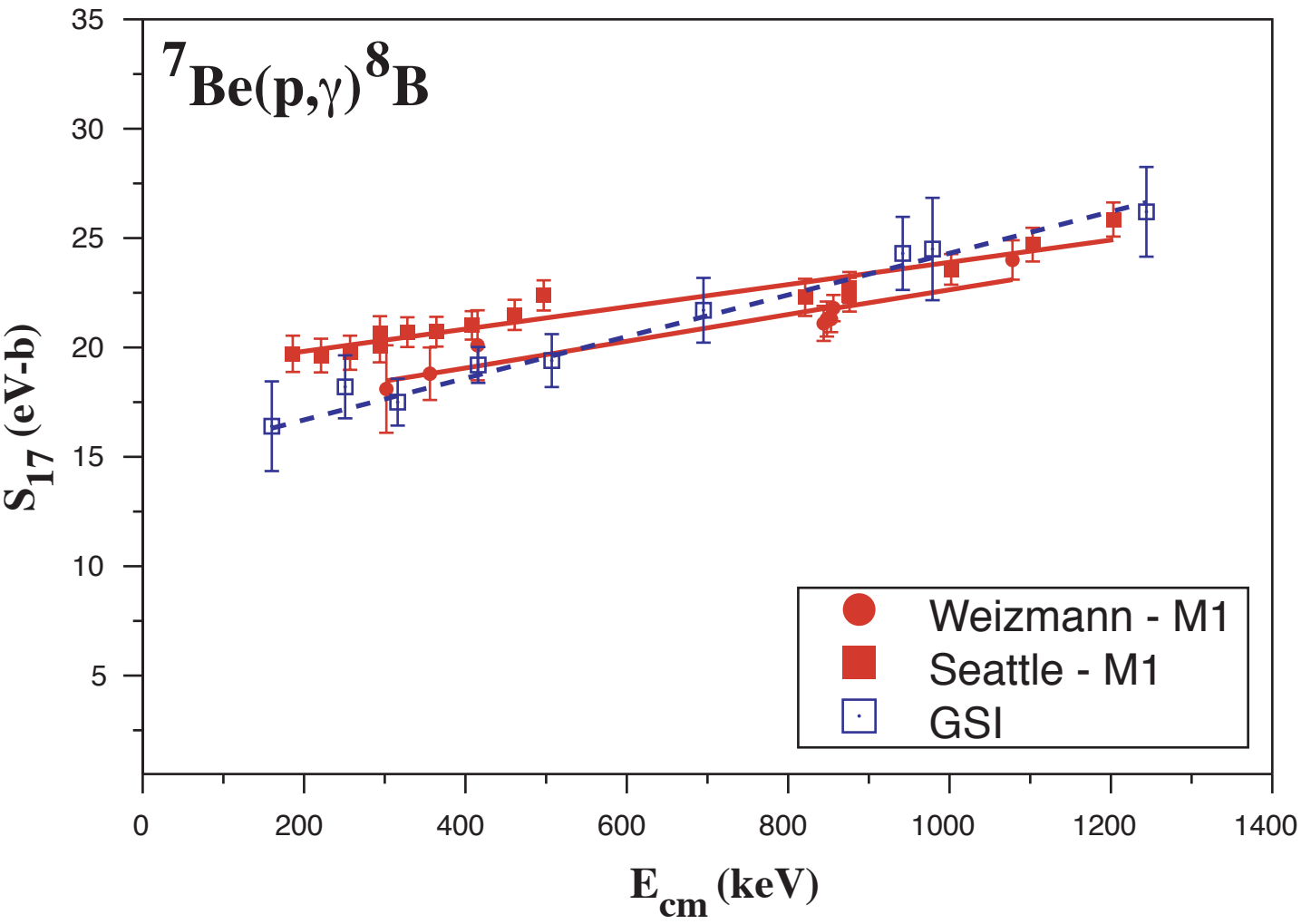


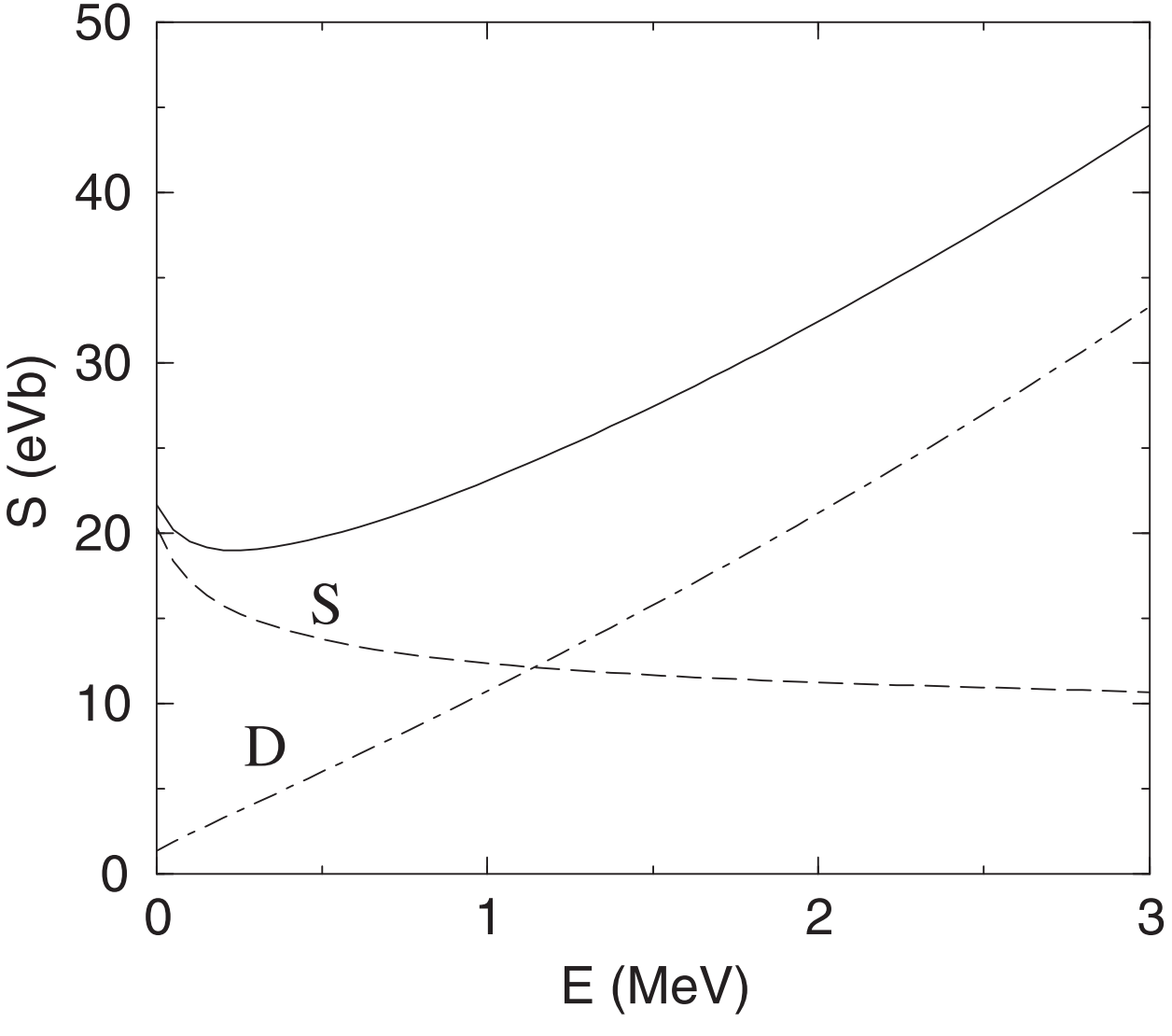
FIG. 1. The reduced χ^2 obtained from fitting the 600 keV angular distribution of the RIKEN data [3] with $\sigma_{CD}(E1) + \sigma_{CD}(E2)$, as discussed in the text.

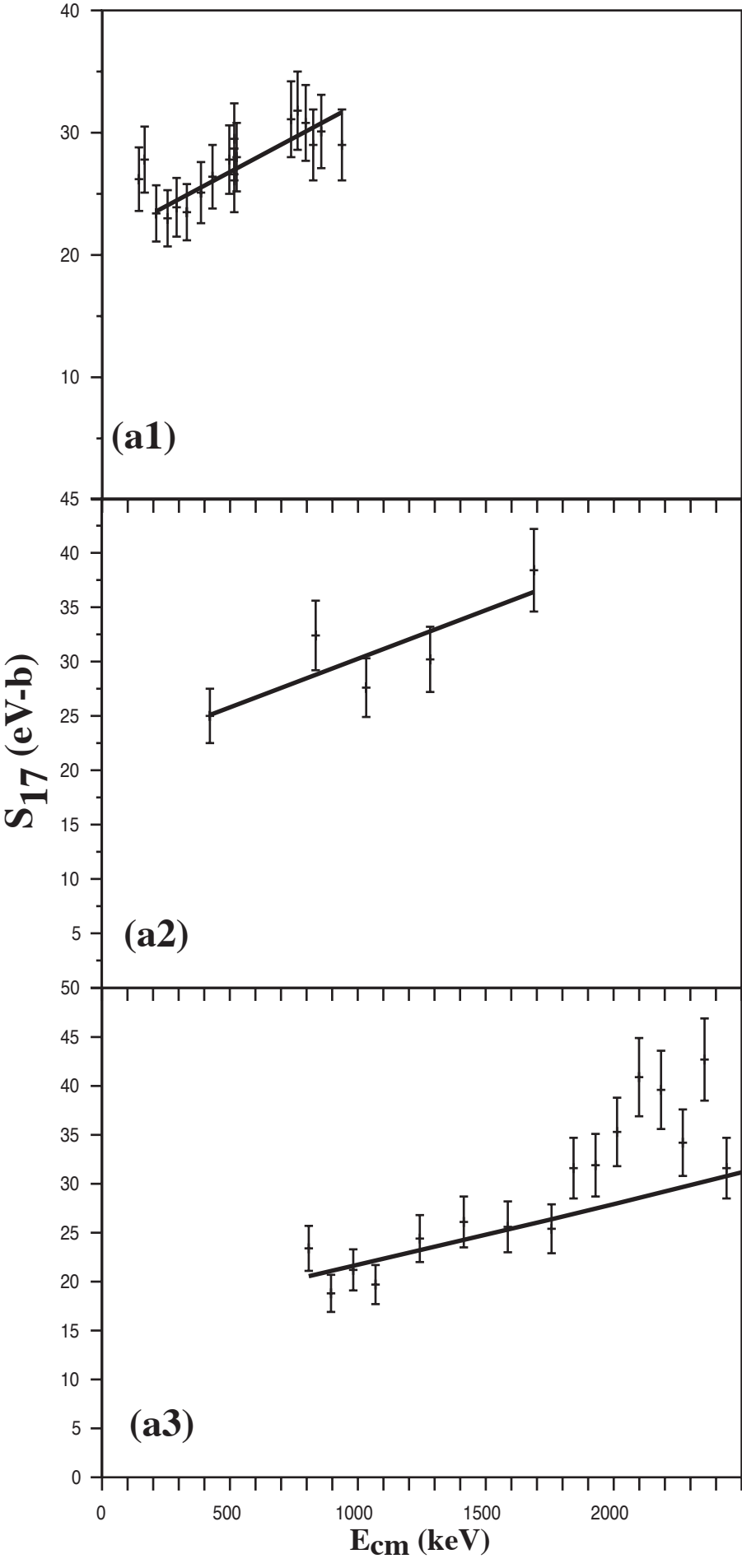

25
20
15
10
5
$S_{17}(0)$ (eV-b)
RIKEN1
RIKEN2
GSI1
GSI2
MSU
Coulomb Dissociation of ^{8}B
1990
1995
2000
Year

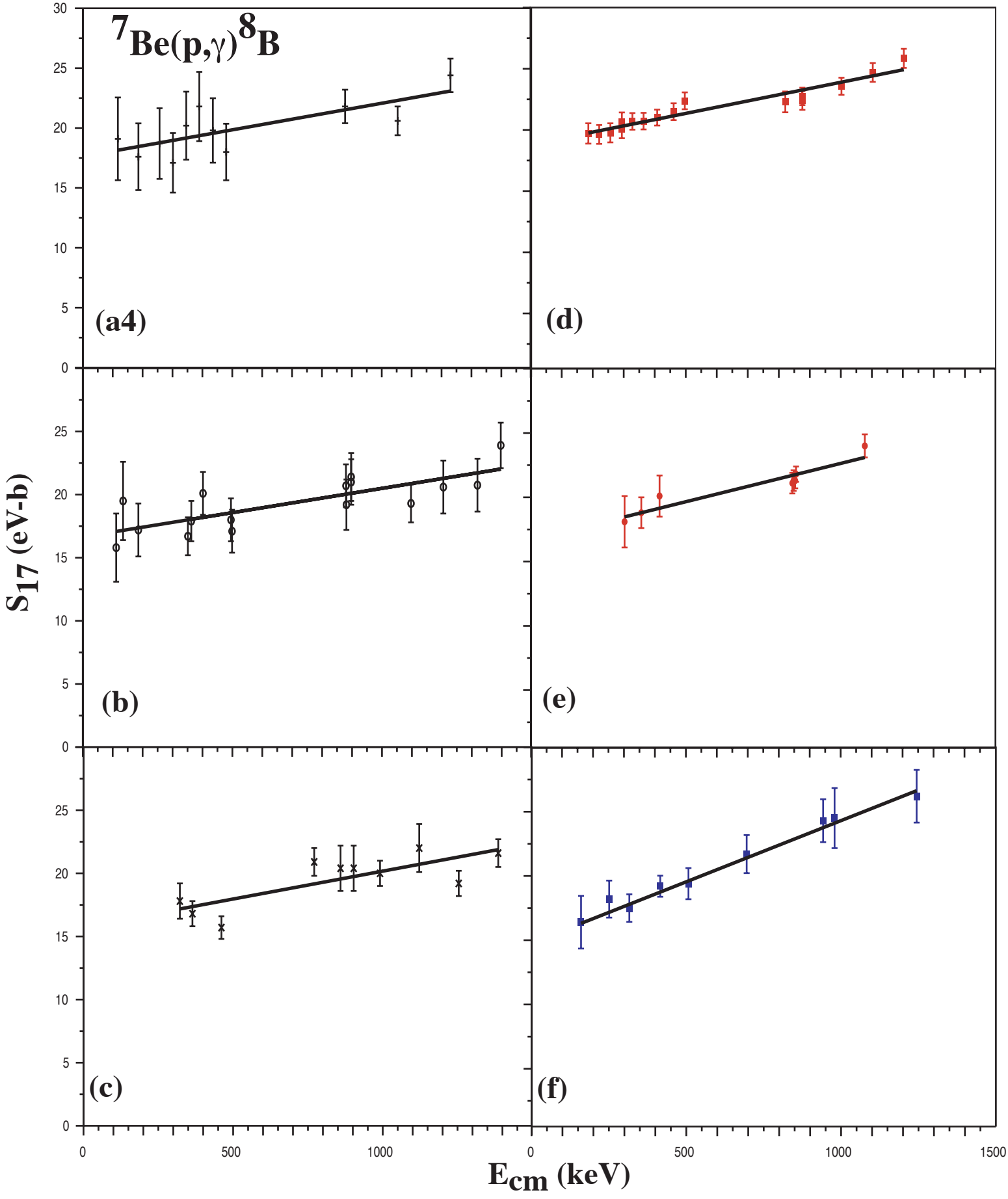

$^{7}Be(p,\gamma)^{8}B$
(a)
Weizmann-M1(03)
GSI2(03)
GSI1(99)
(b)
Weizmann(03)
Seattle(02)
(c)
Seattle(02)
Bochum(01)
Orsay(01)
S_{17} (eV-b)
E_{cm} (keV)
0
200
400
600
800
1000
1200
1400
5
10
15
20
25
30

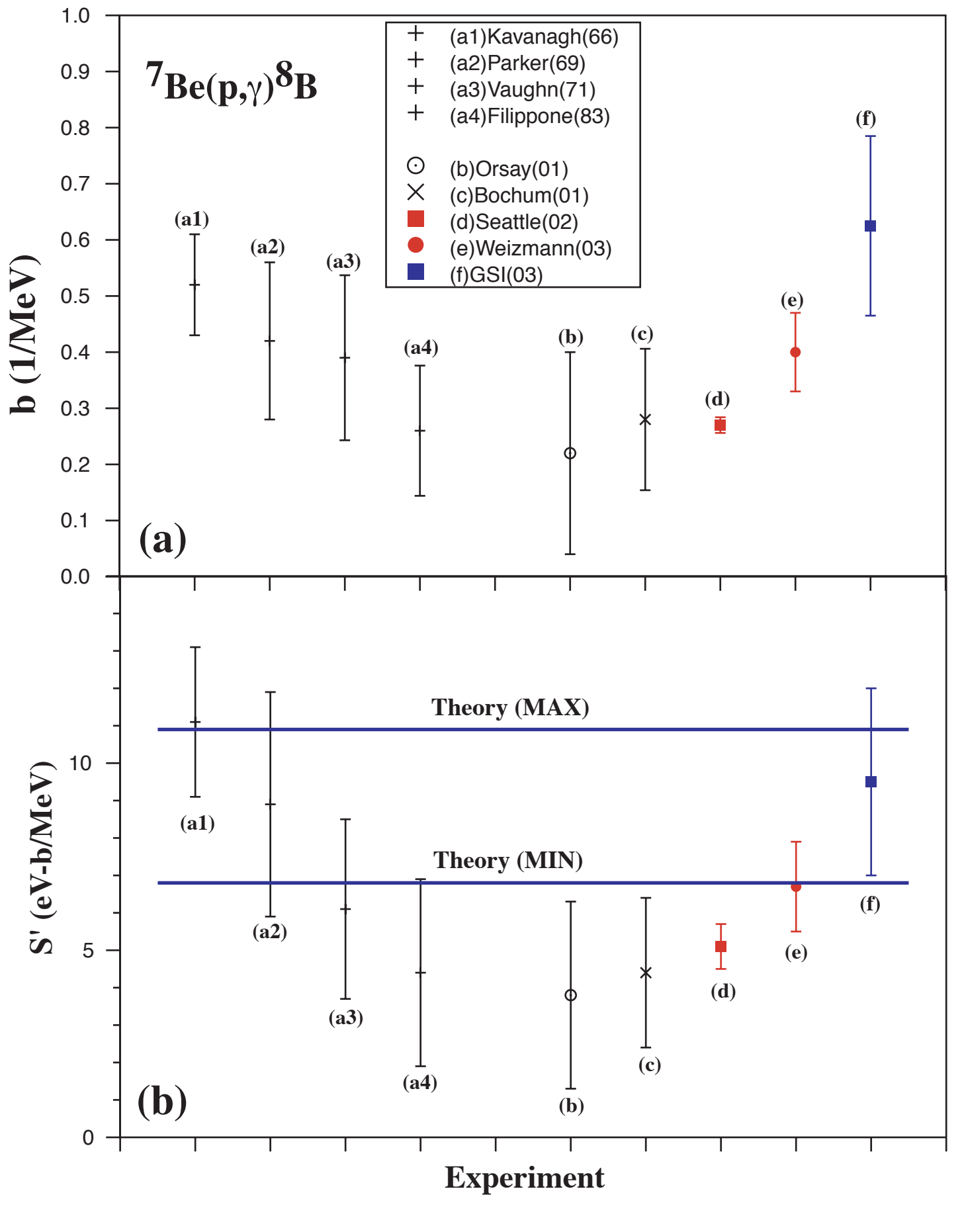

^{7}Be(p,γ)^{8}B
S_{17} (eV-b)
E_{cm} (keV)
35
30
25
20
15
10
5
0
200
400
600
800
1000
1200
1400
Weizmann - M1
Seattle - M1
GSI

Jennings, Kartagalidis, Shoppa; PR C58(1998)3711




(a1)
(a2)
(a3)
S_{17} (eV-b)
E_{cm} (keV)
0
500
1000
1500
2000


^{7}Be(p,γ)^{8}B
(a4)
(d)
(b)
(e)
(c)
(f)
S17 (eV-b)
Ecm (keV)
0
5
10
15
20
25
30
500
1000
1500


$^{7}Be(p,\gamma)^{8}B$
(a1)Kavanagh(66)
(a2)Parker(69)
(a3)Vaughn(71)
(a4)Filippone(83)
(b)Orsay(01)
(c)Bochum(01)
(d)Seattle(02)
(e)Weizmann(03)
(f)GSI(03)
b (1/MeV)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
(a1)
(a2)
(a3)
(a4)
(b)
(c)
(d)
(e)
(f)
(a)
Theory (MAX)
Theory (MIN)
S' (eV-b/MeV)
10
5
0
(a1)
(a2)
(a3)
(a4)
(b)
(c)
(d)
(e)
(f)
(b)
Experiment

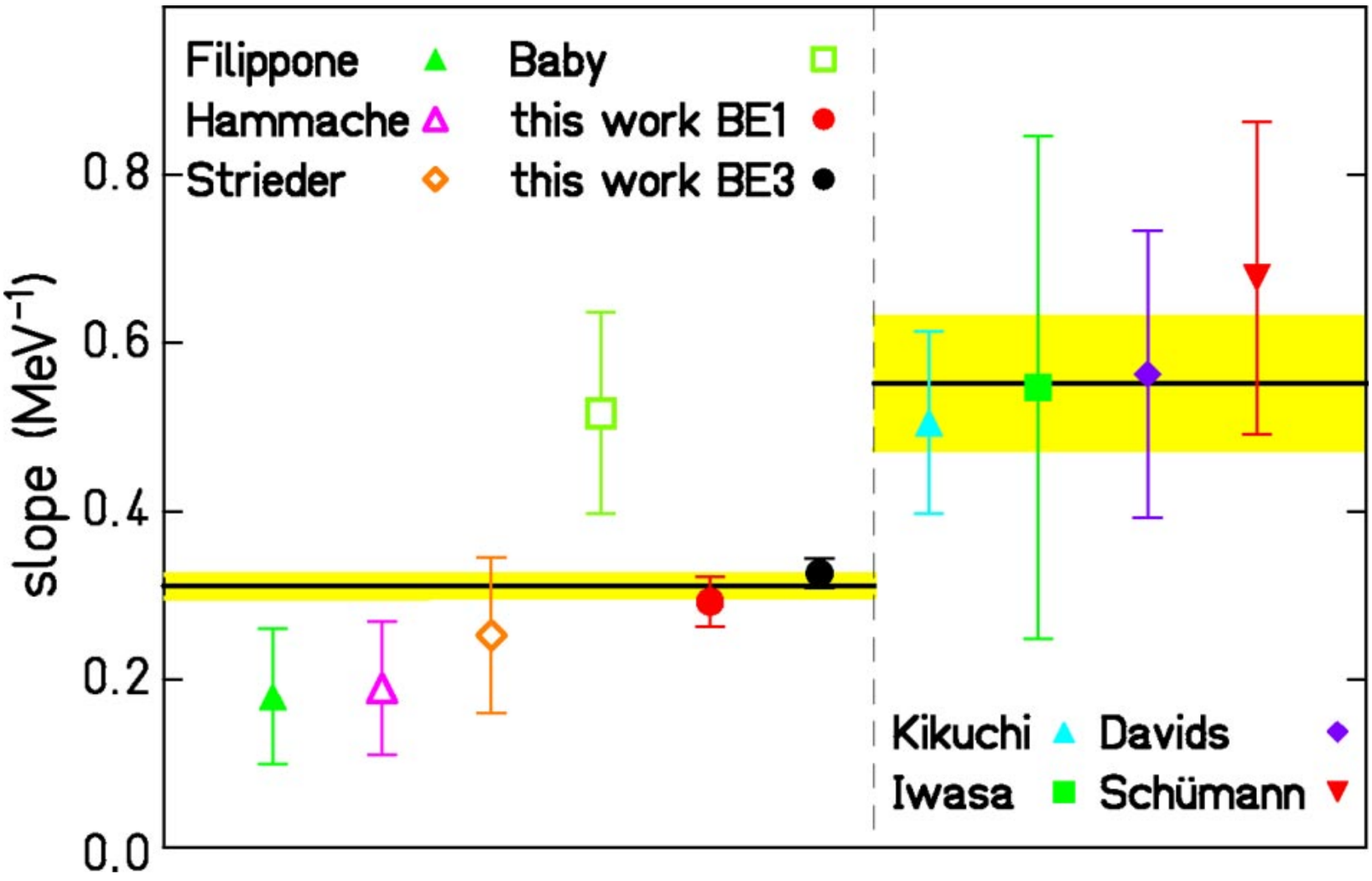
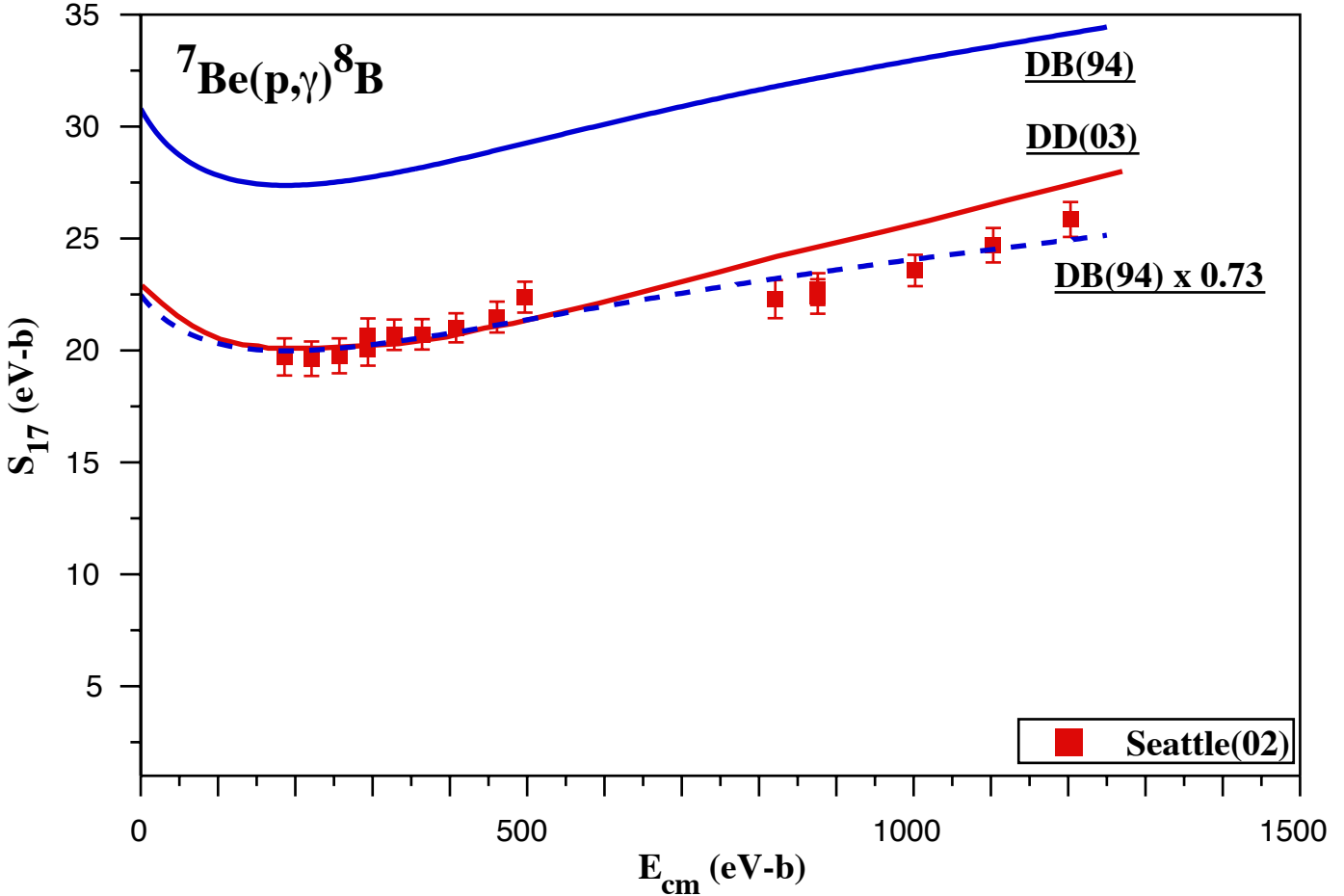
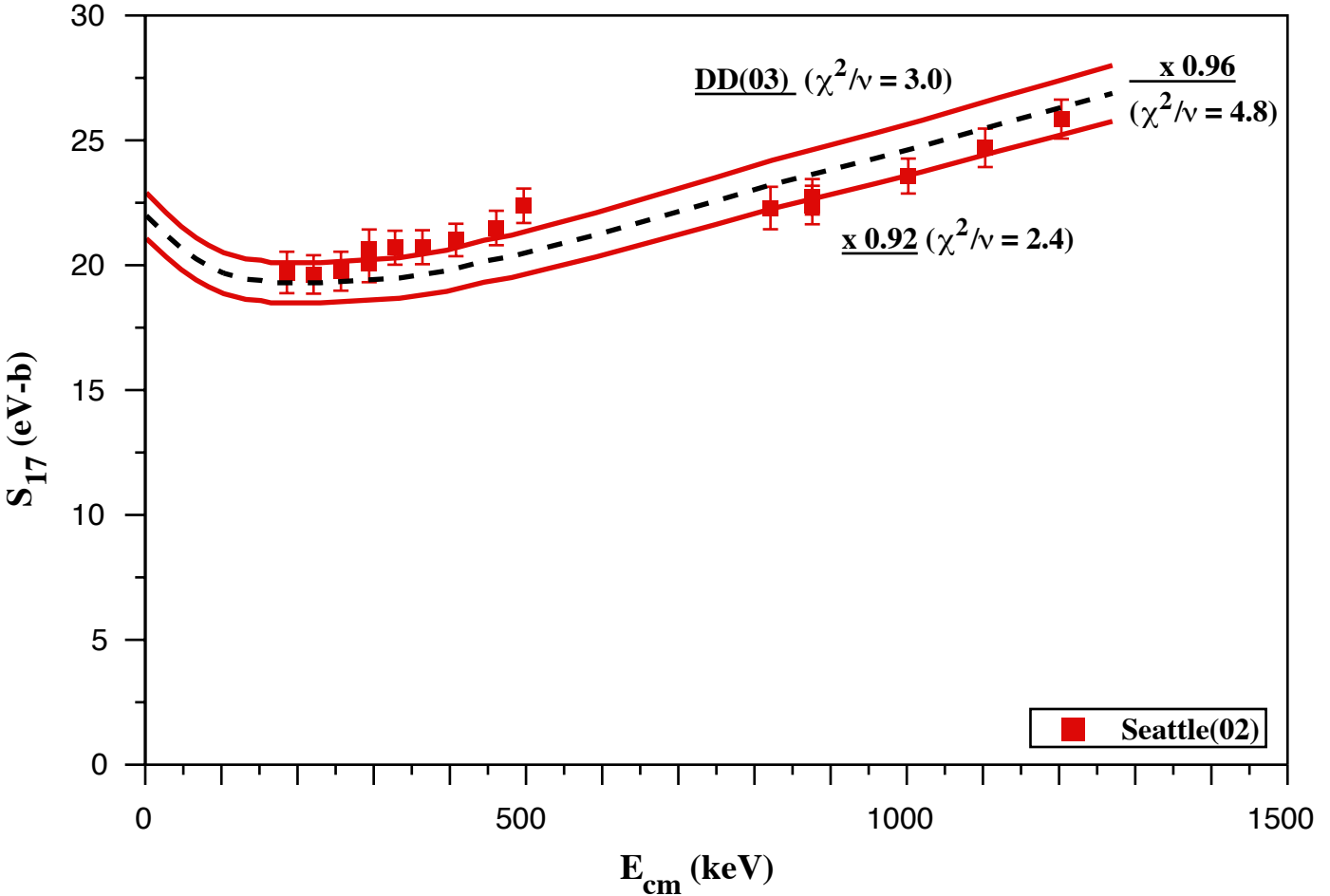
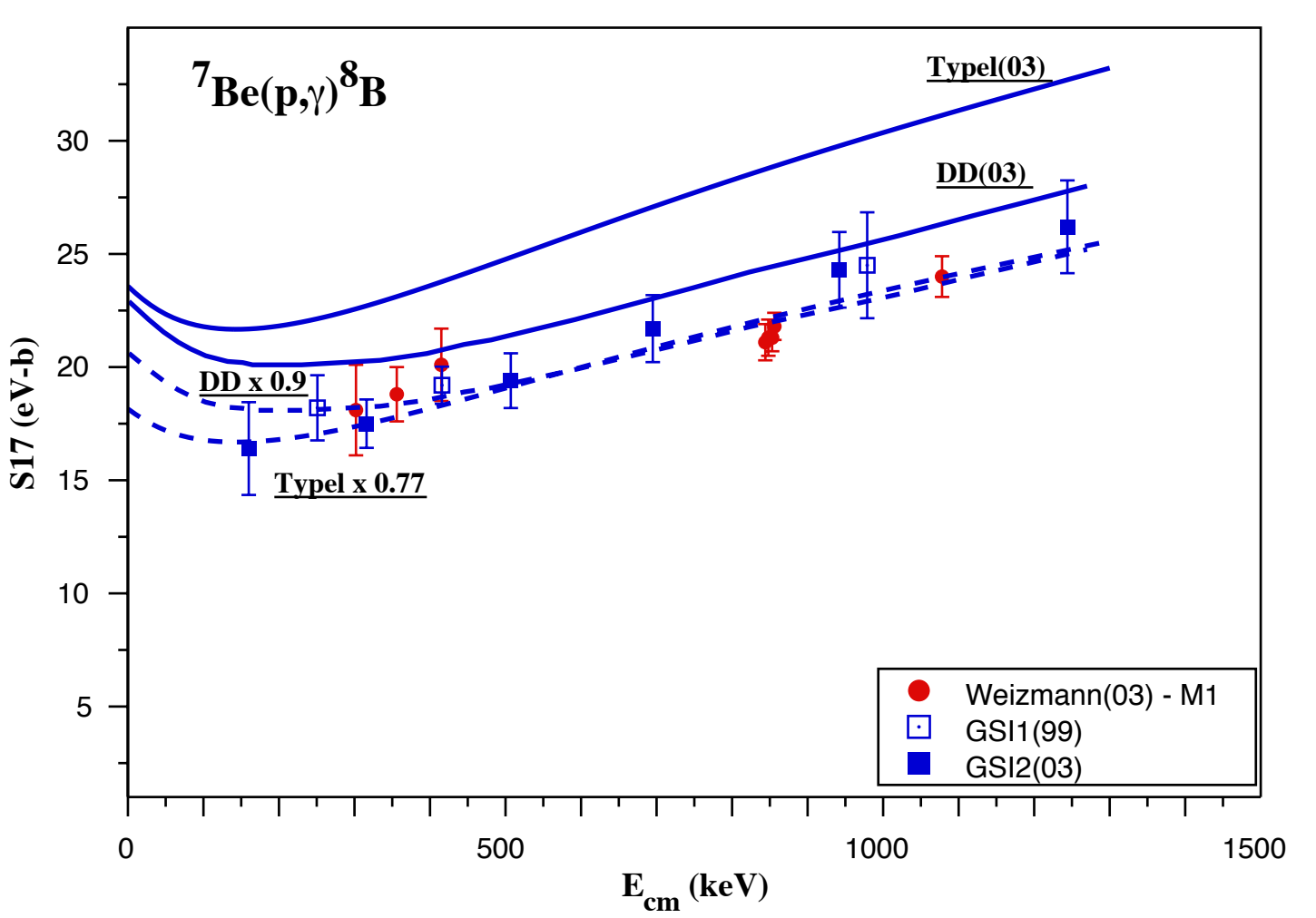


FIG. 19. (Color online) $S_{17}(\overline{E}_{\mathrm{c.m.}})$ slopes determined from straight-line fits to direct $S_{17}(\overline{E}_{\mathrm{c.m.}})$ data (corrected for the 1^+ resonance tail) (left panel) and to $S_{17}(\overline{E}_{\mathrm{c.m.}})$ values inferred from CD experiments (right panel). The horizontal lines and shaded regions correspond to the mean values and uncertainties determined from the direct data and from the CD data, respectively.


^{7}Be(p,γ)^{8}B
DB(94)
DD(03)
DB(94) x 0.73
Seattle(02)
S$_{17}$ (eV-b)
E$_{cm}$ (eV-b)
35
30
25
20
15
10
5
0
500
1000
1500


30
25
20
15
10
5
0
0
500
1000
1500
S17 (eV-b)
Ecm (keV)
DD(03) (χ2/ν = 3.0)
x 0.96
(χ2/ν = 4.8)
x 0.92 (χ2/ν = 2.4)
Seattle(02)


^{7}Be(p,γ)^{8}B
Typel(03)
DD(03)
DD x 0.9
Typel x 0.77
Weizmann(03) - M1
GSI1(99)
GSI2(03)
S17 (eV-b)
E$_{cm}$ (keV)
30
25
20
15
10
5
0
500
1000
1500

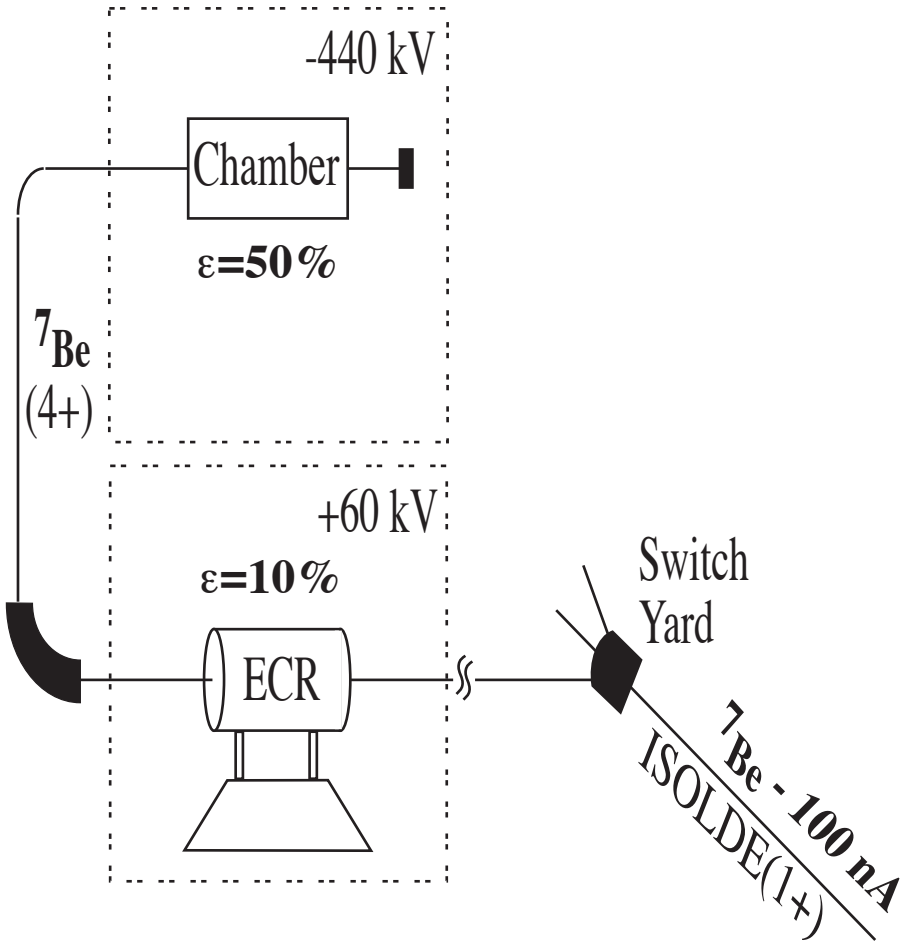
M. Gai; nucl-ex/0312003

S17(0) = 21.2 ±0.5 +0.0 -3.0 (extrap) eV-b

TABLE I: Extrapolated cross section factors using the calculation of Descouvemont and Baye [17]. Only recent high precision results, $S_{17}(0)$ measured with an error of approximately ±5% or better, are shown, excluding the recent results of: RIKEN2(98) (18.9 ± 1.8) [15], Orsay(01) (18.8 ± 1.7) [4] and Bochum(01) (18.4 ± 1.6) [5], as discussed in the text.

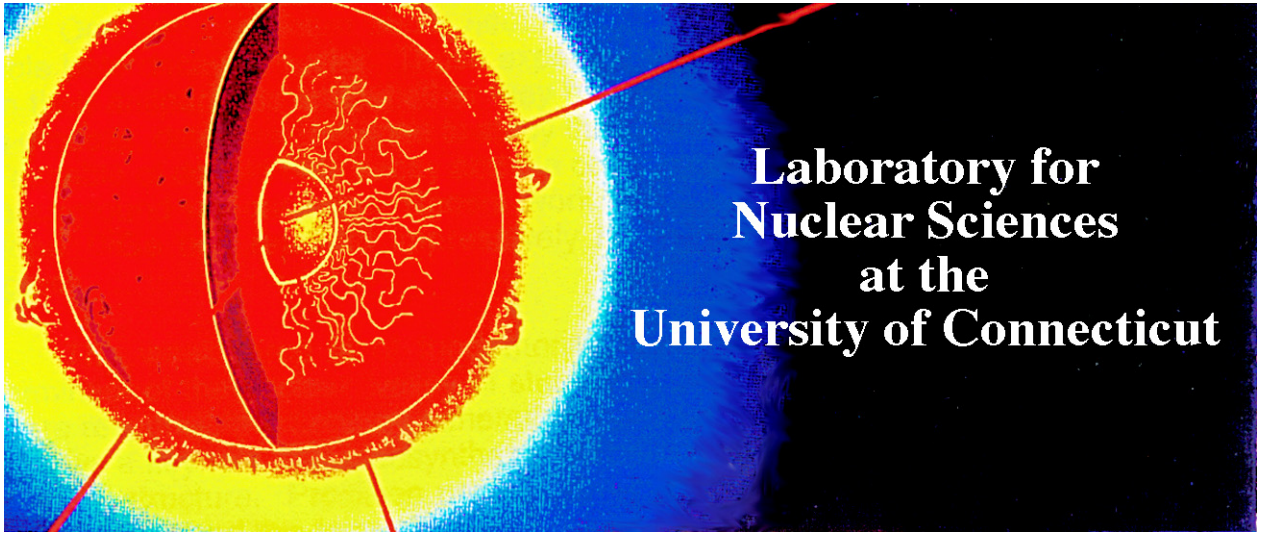
Experiment	$S_1 7(0)$ (eV-b)
GSI1(99) [8]	$20.6\ +1.2\ -1.0$
GSI2(03) [9]	20.8 ±1.3
GSI1 + GSI2:	(20.7 ±0.9)
Seattle(02) [6]	22.1 ±0.6
Weizmann(03) [7]	21.2 ±0.7
Average:	21.2 ±0.5

UConn-Weizmann-LLN-ISOLDE
[LOI(CERN/ISOLDE) - 2001]



Precision Solar (Neutrino) Physics

1. E2 < 1%
2. GSI-Weizmann-Seattle Result
3. $S_{17}(0) = 21.2 \pm 0.6$ eV-b
4. Extrapolation +0.0 – 3.0 eV-b



p.s. The Best Revenge is Having Fun...

Coulomb dissociation of ^{8}B and the low-energy cross section of the ^{7}Be(p,γ)^{8}B solar fusion reaction

F. Schümann[1], F. Hammache[2], S. Typel[2], F. Uhlig[3], K. Sümmerer[2], I. Boettcher[4], D. Cortina[2], A. Förster[3], M. Gai[5], H. Geissel[1], U. Greife[6], N. Iwasa[7], P. Koczon[2], B. Kohlmeyer[4], R. Kulessa[8], H. Kumagai[9], N. Kurz[2], M. Menzel[4], T. Motobayashi[9,10], H. Oeschler[3], A. Ozawa[9], M. Ploskon[8], W. Prokopowicz[8], E. Schwab[2], P. Senger[2], F.Strieder[1], C. Sturm[3], Zhi-Yu Sun[2], G. Surówka[2,8], A. Wagner[11], and W. Walus[8]

[1]*Institut für Physik mit Ionenstrahlen, Ruhr-Universität Bochum, D-44780 Bochum, Germany*
[2]*Gesellschaft für Schwerionenforschung, D-64220 Darmstadt, Germany*
[3]*Technische Universität Darmstadt, D-64289 Darmstadt, Germany*
[4]*Phillips-Universität Marburg, D-35032 Marburg, Germany*
[5]*University of Connecticut, Storrs, CT 06269-3046, U.S.A.*
[6]*Department of Physics, Colorado School of Mines, Golden, CO 80401, U.S.A.*
[7]*Tohoku University, Aoba, Sendai, Miyagi 980-08578, Japan*
[8]*Jagellonian University, PL-30-059 Krakow, Poland*
[9]*RIKEN (Institute of Physical and Chemical Research), Wako, Saitama 351-0198, Japan*
[10]*Rikkyo University, Toshima, Tokyo 171, Japan and*
[11]*Forschungszentrum Rossendorf, D-01314 Dresden, Germany*

(Dated: Version 4.09, January 24, 2003)